

### **REMARKS**

The abstract was amended as the Examiner suggested. Amendments were made to the description as suggested by the Examiner. The amendment made to claim 1 is supported at page 2 lines 5-8, page 5 lines 14-17 and 29-30, page 6 lines 16-20, page 6 line 27 to page 7 line 7, page 7 lines 12-15 and 26-29, page 8 lines 1-8, page 13 lines 11-16, page 15 line 21 to page 16 line 8, page 17 lines 14-17, page 23 lines 5-10, page 24 lines 3-10, and in the Examples. Claims 6-9, 11, 13-14, 25-29, 31-32, and 43-46 were amended as suggested by the Examiner to clarify the language. Claim 10 was amended to correct an inadvertent omission. The amendment of claim 10 is supported at p. 19 lines 17-20.

#### **1. Status of claims**

After amendment, claims 1-58 are pending. Claims 1-58 have been rejected. No new matter has been added. Applicant requests reconsideration of all pending claims.

#### **2. Objection**

The Examiner objected to the abstract of the application, because of the use of the terms "comprising" and "comprises." Applicant disagrees with the objection, but has amended the abstract to expedite prosecution.

#### **3. Rejections**

##### **Rejections under 35 USC §112, second paragraph**

Claims 1-58 were rejected by the Examiner under 35 USC §112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter of the

invention. The Examiner objected to Claim 1 asserting that "heating at least one of the feed stream, the azeotroping agent..." provides for ambiguity, because the claim initially recites mixing them. Furthermore, the Examiner alleges that the claim is incomplete, because it lacks a process connection between the mixing and the heating step. The Examiner objected to Claim 1 as not positively reciting a distilling step. One skilled in the art would recognize that distillation involves the production of a vapor and separating that vapor. Applicant has amended the language of Claim 1 to make this clearer. Applicant has amended the language of Claim 1 to make clear the relationship between the mixing step and heating step. The amendment should also remove any ambiguity regarding heating of the feed stream or the azeotroping agent.

The Examiner objected to claims of the present application as being indefinite, contending that azeotropes are normally defined by their composition and pressure. The azeotroping agents of the claimed invention are capable of forming an azeotrope with an organic acid. (See page 5 lines 3-6.) Thus, the azeotroping agent is selected so that it is capable of forming an azeotrope with a particular organic acid. Furthermore, a mixture of the azeotroping agent and an acid is heated to a temperature sufficient to produce a vapor stream comprising the azeotrope. As pointed out at page 18 lines 13-24, determining the temperature needed at a pressure to produce an azeotrope is known in the art.

The Examiner asserts that the terminology in the claims is improper, citing use of the "the azeotroping agent" in the dependent claims instead of "at least one azeotroping agent" recited in claim 1. Applicant has amended the claims accordingly. The term "further comprising" has been used in amended claim 8 as suggested by the Examiner. Claim 11 has been made dependent on claim 10 to overcome the Examiner's objection that a first bottoms stream was not recited in claim 11. Dependent claim 25 has been amended to clarify its language and to

overcome the Examiner's objection that "fermentation broth" is at odds with the "feed stream" in claim 1.

**Provisional rejections for obviousness-type double patenting and double patenting**

The Examiner contends that the claims in this application are not patentably distinct from the claims in the copending and commonly owned applications no. 09/809,534 and no. 09/809,649. Applicant does not agree that the claims in this application, as amended, are patentably indistinct from the claims in the other application. However, since this is only a provisional rejection, applicant will not comment further at this time.

**Rejection of claims 1-6, 8-12, 19-24, 30-48, and 50 under 35 USC §103(a)**

The Examiner rejected claims 1-6, 8-12, 19-24, 30-48, and 50 as being obvious over any one of Baniel *et al.* (US 6,187,951), Mercier (US 4,100,189) or Horlenko (US 3,718,545), in view of Izard (US 3,419,478), or Benecke *et al.* (US 5,319,107).

The claimed invention is directed to an azeotropic distillation process for recovery of monocarboxylic, dicarboxylic and tricarboxylic acids having from 2 to 8 carbon atoms from a feed stream. The feed stream comprises at least one of an organic acid ammonium salt, an organic acid amide, or an alkylamine-organic acid complex, and the feed stream is mixed with an azeotroping agent. The ammonium salt, amide or alkylamine-organic acid complex in the mixture is decomposed to produce organic acid. A first vapor stream that comprises at least one first azeotrope comprising (a) the organic acid and (b) the azeotroping agent is produced in the claimed process.

Baniel *et al.* does not teach a first vapor stream comprising a first azeotrope that comprises both an azeotroping agent and organic acid. The Examiner specifically cites Baniel *et al.* lines 25-55 of page 13, stating that the citation teaches "that an organic acid such as lactic acid can be separated or recovered by a distillation method." Applicant respectfully disagrees that the distillation taught by Baniel *et al.* is comparable to the distillation of the claimed invention.

Baniel *et al.* teaches use of trialkyl amines for the extraction of lactic acid (col. 3 lines 36-53), wherein the extraction results in a lactic acid rich organic phase comprising the trialkyl amine. The trialkyl amines can be used with a solvent that comprises a hydrocarbon (e.g., compatible organic solvent). (See col. 4 lines 28-46 and col. 12 lines 2-18.) It is further taught that "It is preferable to remove such solvents prior to the back extraction with water" of the organic phase, and it is preferable to remove the solvent by "azeotropic steam distillation" (col. 4 lines 54-55 and col. 13 lines 17-22). Furthermore, Example 3 of Baniel *et al.* teaches "An extractant mixture comprised of 80% by weight tridodecylamine and 20% by weight n-butanol, was contacted with 30% by weight aqueous lactic acid in sufficient quantity to produce a loading of 6.9% in the organic phase. 230 g of this material was added to a stirred round bottom flask connected to a distillation apparatus.... Initial condensate fractions included butanol and water. A later fraction showed recovery of 97% by weight of the original lactic acid." The butanol and water form a known azeotrope during distillation, and lactic acid and its oligomers were recovered without solvent. (See col. 14 line 65 to col. 15 line 13.) Thus, while Baniel *et al.* teaches an azeotrope comprising water and solvent, it does not teach production of an azeotrope comprising azeotroping agent and organic acid, as in the claimed invention.

The Examiner asserts that Mercier "discloses substantially the process or method steps as claimed." Applicant respectfully disagrees with the Examiner's assertion, because Mercier does not teach an azeotrope comprising azeotroping agent and organic acid, as in the claimed invention. Mercier teaches "the decomposition of the ammonium acetate is conducted in a suitably heated distillation column, equipped with trays defining a reaction zone, and in the presence of a third component which forms, with water, a heteroazeotrope of minimum boiling point, said third component advantageously being identical to the solvent of extraction." (See col. 2 lines 48-54, col. 5 lines 19-26, and claims 1, 6, 7, and 16.) The third component is described at col. 3 lines 5-45. Mercier further teaches that ammonia evolved from the decomposition is evolved as a top fraction, and "water is entrained heteroazeotropically by the third component.... while anhydrous acetic acid is obtained as bottoms" (col. 2 lines 63-67, and col. 3 lines 67-68). Thus, while Mercier teaches an azeotrope comprising water and third component, an azeotrope comprising organic acid and azeotroping agent, as in the claimed invention, is not taught.

Horlenko teaches processes for the recovery of an organic acid having one carbon atom (e.g., formic acid). (Abstract, and col. 2 lines 8-11, etc.) Formic acid has different chemical properties than the carboxylic organic acids having 2 to 8 carbon atoms of the claimed invention. Furthermore, Horlenko does not teach a feed stream that comprises at least one of an organic acid ammonium salt, an organic acid amide, or an alkylamine-organic acid complex as in the claimed invention. The organic acid of the salt, amide or complex of the claimed invention is selected from the group consisting of monocarboxylic acids, dicarboxylic acids, and tricarboxylic acids having from 2 to 8 carbon atoms. Decomposition by heating a mixture of the feedstream and an azeotroping agent is used to produce organic acid in the claimed invention.

Horlenko does not teach decomposition of at least one of an organic acid ammonium salt, an organic acid amide, or an alkylamine-organic acid complex, as in the claimed invention.

The Examiner alleges that "It would have been obvious to one of ordinary skill in the art, at the time the invention was made, to incorporate the teachings of Izard or Benecke *et al.* to the process of Baniel, Horlenko, or Mercier." Izard teaches the recovery of acetic acid from an anhydrous mixture of acetic acid and N,N-dimethylacetamide (DMAC) (Abstract, and col. 1 lines 30-39, and Examples).

Baniel *et al.* does not teach recovery of acetic acid or DMAC, but teaches recovery of lactic acid from an aqueous lactate solution (e.g., a fermentation broth) (Abstract and col. 6 lines 16-20). Applicant suggests that it would not be obvious to one of skill in the art to combine methods from Izard and Baniel, since methods of recovering different organic acids are taught. Furthermore, one teaches recovery of lactic acid from an aqueous solution (Baniel), while the other teaches recovery of an acetic acid from an anhydrous solution (Izard).

Horlenko ('545) teaches processes for the recovery of an organic acid having 1 carbon atom (e.g., formic acid). (Abstract, and col. 2 lines 8-11, etc.) As discussed above, Izard teaches recovery of acetic acid. Formic acid has different chemical properties than acetic acid. Furthermore, Horlenko does not teach decomposition of at least one of an organic acid ammonium salt, an organic acid amide, or an alkylamine-organic acid complex, as in the claimed invention. Izard also does not teach decomposition of at least one of an organic acid ammonium salt, an organic acid amide, or an alkylamine-organic acid complex. Thus, the two references taken together do not teach every element of the present invention.

Mercier teaches decomposition of ammonium acetate (col. 2 lines 48-54) to produce acetic acid. Mercier does not teach recovery of acetic acid from an anhydrous mixture, as Izard

does. Izard does not teach recovery of acetic acid by decomposition of ammonium acetate, as taught by Mercier. Since Mercier teaches recovery of acetic acid from an aqueous solution (Abstract), and in contrast, Izard teaches recovery of acetic acid from an anhydrous mixture (see above), and since Mercier teaches decomposition of ammonium acetate to produce acetic acid, and Izard does not teach production decomposition of a compound to produce acetic acid. Applicant respectfully suggests that one skilled in the art would not find any motivation to combine the teachings of Mercier and Izard.

Benecke *et al.* ('107) does not teach azeotropes comprising an organic acid and an azeotroping agent, as in the claimed invention. Furthermore, Benecke teaches recovery and production of cyclic esters of hydroxy carboxylic acids involving removal of water via an azeotrope comprising water and an azeotropic solvent (Abstract, claims 3-7, and col.7 lines 27-29, and col. 10 lines 38-41, among others). Neither Baniel nor Benecke teach a first azeotrope comprising an organic acid and azeotroping agent, and thus, the combined references do not teach all the elements of the claimed invention.

While Horlenko teaches recovery of formic acid (see above), Benecke teaches processes for the recovery of cyclic esters. Benecke teaches away from processes involving formic acid (col. 3 lines 65-68 and col. 4 lines 47-67), as it is known in the art that formic acid does not form a cyclic ester. Formic acid is not a hydroxy organic acid, and hydroxy organic acids are used to produce the cyclic esters as taught by Benecke (Abstract and col. 2 lines 49-57, among others). In light of the discussion above, it seems that one skilled in the art would not have any motivation to combine the teachings of the two references.

Neither Benecke nor Mercier teach an azeotrope comprising azeotroping agent and organic acid, as in the claimed invention. Thus, the combined references do not teach all the elements of the claimed invention.

In light of the discussion above, Applicant respectfully asks that the rejection of claims 1-6, 8-12, 19-24, 30-48, and 50 be withdrawn.

**Rejection of claims 7 and 13-18 under 35 USC §103(a)**

The Examiner further rejected claims 7 and 13-18 as being obvious over Baniel *et al.* ('951), Mercier (US '189) or Horlenko ('545), in view of Izard ('478), or Benecke *et al.* ('107) in further view of Tcherkawsky (US 3,432,401) or Iffland *et al.* (US 5,945,560). Claim 1 is nonobvious over Baniel *et al.*, Mercier or Horlenko, in view of Izard, or Benecke *et al.*, as discussed above. Claims 7 and 13-18 depend directly or indirectly from claim 1, and they relate to the first azeotrope of claim 1 being a heteroazeotrope. Presumably the Tcherkawsky and Iffland *et al.* references were meant to address heteroazeotropes of claim 7 and 13-18. However, neither Tcherkawsky nor Iffland *et al.* teach a heteroazeotrope comprising an azeotroping agent and monocarboxylic, dicarboxylic or tricarboxylic organic acids having from 2 to 8 carbon atoms, as in the claimed invention. In view of this discussion, Applicant requests rejection of claims 7 and 13-18 be withdrawn.

**Rejection of Claims 25-29, 49, and 51-58 under 35 USC §103(a)**

The Examiner further rejected claims 25-29, 49, and 51-58 under 35 USC §103(a) as being obvious over Baniel *et al.*, Mercier and Horlenko as applied to the claims discussed above, and in further view of Kulprathipanja *et al.* (US 5,068,418). Claims 25-29, 49, and 51-58 depend directly or indirectly from claim 1. Claim 1 is nonobvious over Baniel *et al.* ('951), Mercier (US '189) or Horlenko ('545) for the reasons discussed above. Kulprathipanja teaches recovery of



lactic acid from a fermentation broth using a weakly basic or strongly basic anionic exchange resin (Abstract). Neither Baniel nor Mercier teach a first vapor stream comprising a first azeotrope comprising both an azeotroping agent and organic acid, and Kulprathipanja does not teach an azeotropic distillation. Thus, either Baniel or Mercier taken together with Kulprathipanja do not teach every element of the claimed invention (e.g., a first azeotrope comprising both an azeotroping agent and organic acid).

Neither Kulprathipanja nor Horlenko teach decomposition of at least one of an organic acid ammonium salt, an organic acid amide, or an alkylamine-organic acid complex by heating a mixture of the feedstream and an azeotroping agent to produce organic acid, as in the claimed invention. Thus, the teachings of Horlenko taken together with the teachings of Kulprathipanja do not teach every element of the claimed invention.

Applicant respectfully requests that the rejection of these claims be withdrawn.

None of the references alone or combined teach or suggest the claimed invention. Thus, in light of the amendment and the discussion above, Applicant believes claims 1-58 are now in condition for allowance.

The Examiner is invited to contact the undersigned patent agent at (713) 934-4077 with any questions, comments or suggestions relating to the referenced patent application.

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